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(54) Fail-safe flame monitoring means

(57) A flame monitoring means is arranged for selective use with an ionisation sensor (2) or a UV-sensor (3) which are connected in series with a first capacitor (7) to an *a.c.* voltage (U_1). The sensor current charges up the capacitor (7). A threshold switch (74) provides for voltage-dependent discharging of the capacitor (7) and transmits the charge thereof partly to a second capacitor (15), and changes the charge thereof. The voltage thereof influences the input (19) of a trigger stage (42, 43, 44). An output switch (44) of the trigger stage short-circuits the supply circuit of a flame relay (34) in a temporally restricted permissible switching cycle. In the short-circuited condition, a capacitor (35) is discharged by way of the flame relay (34) which is then energised, and the subsequent charging current holds the flame relay (34) in an energised condition. The output switch (44) also short-circuits a further capacitor (60) and, by way of a trigger circuit (56, 55), controls a flap (53) for masking the UV-radiation for a restricted period of time. Only the restricted UV-radiation permits the production of the permissible switching cycle, so that the flame relay (34) remains energised.

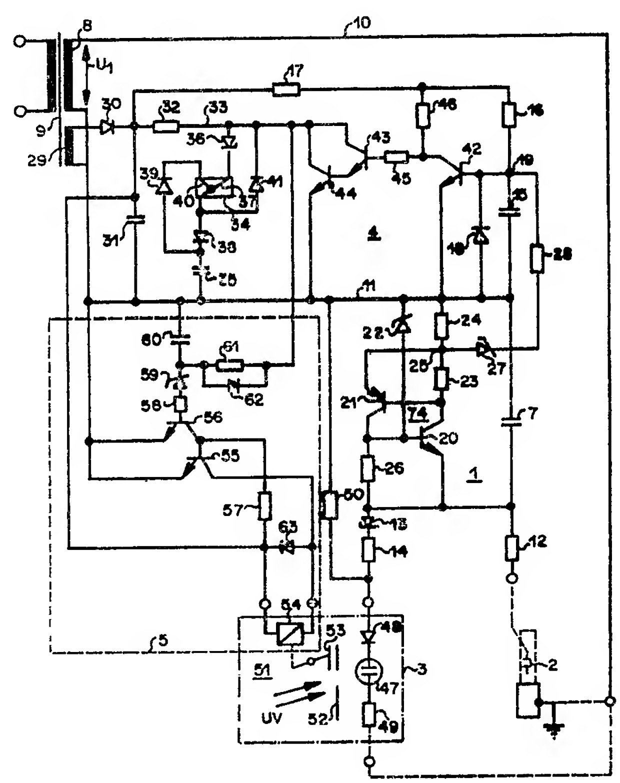

Fig. 1

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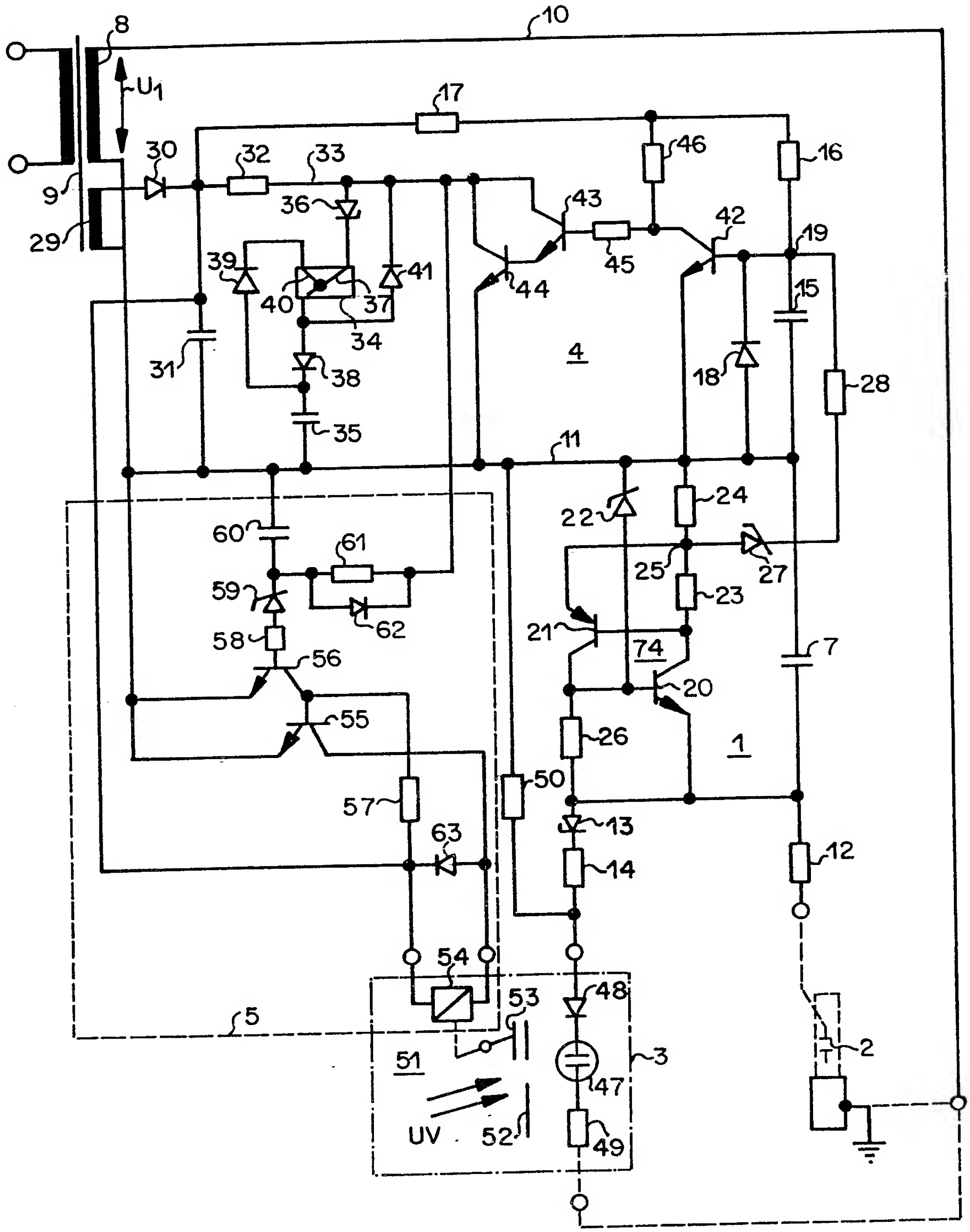
Fig. 1



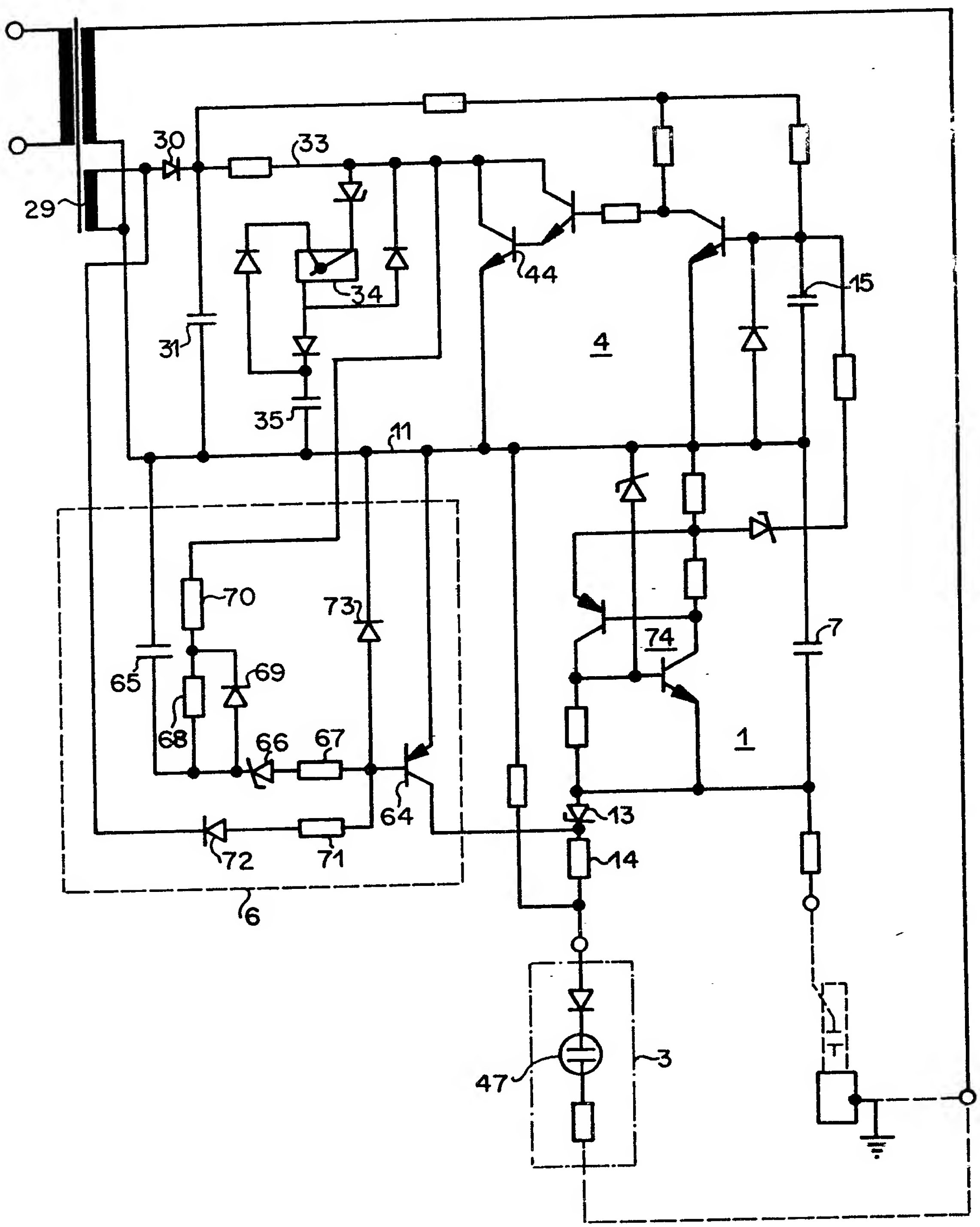


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Fig. 2

SPECIFICATION

Fail-safe flame monitoring means

This invention relates to fail-safe flame monitoring means.

For fully automatic starting and monitoring of oil or gas burners, flame monitoring means are required. The purose of such means is to detect the presence of a flame at any time. The flame monitoring means, together with flame sensing means thereof, must be substantially fail-safe. That is to say, any possible defect in a component must be indicated by a 'flame extinguished' signal. This may be effected by checking the functionability of the flame sensing means before each operation of starting up the installation. Installations are also used in which two flame monitoring means operate independently of each other, the two means being monitored for their signal production always being the same. This involves a high level of expenditure. Also known are flame monitoring means with sensing means which respond in particular to ultra-violet radiation, hereinafter referred to as UV-cells, in which the radiation is masked off from the sensing means at least once per second at the same rhythm and with a constant cycle ratio, thereby to monitor the capacity of the UV-cell to be extinguished within the permitted signalling time. However, a constant cycle ratio results in perceptible losses in sensitivity.

In addition, it is known from German Published Patent Application No. DE 2 809 993 A to use a voltage, influenced by an ionisation sensor, across a capacitor, for controlling an amplifier, and to superimpose on that *d.c.* voltage, with an additional transistor, an alternating signal which is dictated by the mains frequency. A series circuit of two transistors with a flame relay and two capacitors holds the flame relay in an energised condition only when the alternating signal is superimposed on the flame signal, thereby demonstrating that the amplifier is functional. However, this circuit is not fail-safe because the circuit components thereof are not all monitored; if, for example, one transistor has a short-circuit, this is not detected, and any further short-circuiting of one of the other components is then no longer tested and can result in simulation of a flame.

According to the present invention there is provided a flame monitoring means comprising

a series circuit of a first capacitor and a flame sensing means, said series circuit being connected to receive an *a.c.* voltage in use of the flame monitoring means,

a flame relay,

a threshold switch arranged to be controlled by the voltage across the first capacitor and operative to produce a signal for energising the flame relay when the threshold switch reaches a switching threshold thereof,

a switching means for periodically blocking the signal to the flame replay and simultaneously discharging the first capacitor,

a circuit which which includes the flame relay and can hold the flame relay in a position thereof indicating a flame, only by an alternating signal,

a second capacitor connected by at least one charging resistor to a direct current source, the switching condition of the switching means being determined by the voltage at the second capacitor, and

first and second discharge circuits activatable by the threshold switch for discharging the first capacitor, the first discharge circuit serving to change the charge on the second capacitor and comprising a parallel circuit of the second capacitor and comprising a parallel circuit of the second capacitor with a diode which limits the magnitude of the changed-polarity voltage across the second capacitor, a resistor, and a voltage-dependent switch which interrupts the charge-changing process, and the second discharge circuit including a resistor which determines the residual discharge time of the first capacitor.

Embodiments of the invention described hereinbelow comprise flame monitoring means which, while being of low cost, permit fail-safe flame monitoring (in particular of flames of oil and gas burners) and in addition can operate selectively both with ionisation electrodes and also with a UV-cell.

The invention will now be further described, by way of illustrative and non-limiting example, with reference to the accompanying drawings, in which:

Figure 1 shows a first fail-safe flame monitoring circuit embodying the invention, the circuit having a first UV-sensor circuit; and

Figure 2 shows a second, similar flame monitoring circuit embodying the invention, the circuit having a second UV-sensor circuit.

The fail-safe flame monitoring circuits described hereinafter, of which that shown in Fig. 1 is described first, essentially comprise the following circuit portions which are set out according to their functional purpose:

a sensor circuit 1 having pulse generating means, which can be operated either with an ionisation sensor 2 or with a UV-sensor 3;

a flame relay circuit 4; and

a control circuit 5 (Fig. 1) and 6 (Fig. 2) for alternative use when operating with a UV-sensor.

The sensor circuit 1, which will now be described with reference to Fig. 1, comprises a series circuit of a flame sensor (either the ionisation sensor 2 or the UV-sensor 3) and a first capacitor 7. Said series circuit is supplied with an *a.c.* voltage U_1. The *a.c.* voltage U_1 is taken from a first winding 8 of a mains transformer 9 and connected by means of a

first line 10 to earth and to the two sensors 2 and 3, while a bus line 11 serves as the second line. The capacitor 7 connects the line 11 on the one hand to the ionisation sensor 2 by way of a protective resistor 12 and on the other hand to the UV-sensor 3 by way of a Zenor diode 13 and a resistor 14.

The further description of Fig. 1 first proceeds in connection with use of the ionisation sensor 2.

A *d.c.* voltage, the polarity of which is such that the side of the line 11 is positive, is produced across the capacitor 7 by the rectification effect of a flame.

A second capacitor 15 is connected between the line 11 and a *d.c.* voltage source which is positive with respect to the line 11 and which is described hereinafter, by way of two charging resistors 16 and 17. A diode 18 is connected in parallel with the capacitor 15 in a sense in which it does not conduct in response to the above-mentioned *d.c.* voltage. The junction between the diode 18 and the second capacitor 15 and the charging resistor 16 forms an input 19 for the flame relay circuit 4.

The voltage across the first capacitor 7 is monitored by a triggering threshold switch 74 which is primarily formed by first and second transistors 20 and 21 and a Zener diode 22. The collector-emitter path of the first transistor 20 is connected in series with two resistors 23 and 24 and in parallel with the first capacitor 7, while the base of the first transistor 20 is connected to the line 11 by way of the Zener diode 22. In addition, starting from the junction 25 between the two resistors 23 and 24, there is a series circuit comprising the emitter-collector path of the second transistor 21 and a resistor 26 to the negative side of the capacitor 7. The base of the first transistor 20 is also connected to the side of the resistor 26 which is connected to the second transistor 21, while the base of the second transistor 21 is connected to the junction between the resistor 23 and the collector of the first transistor 20. A series circuit comprising a further Zener diode 27 and a resistor 28 is connected between the junction 25 and the input 19 of the flame relay circuit 4.

Before the mode of operation of above-described sensor circuit is described, the flame relay circuit 4 will be described. The flame relay circuit 4 is supplied from the above-mentioned *d.c.* voltage source, which comprises a second winding 29 of the mains transformer 9, a diode 30 and a smoothing capacitor 31, the negative pole of the voltage source being connected to the line 11. The *d.c.* voltage source supplies the flame relay circuit 4 by way of a charging resistor 32 and a supply line 33. Between the line 33 and the bus line 11 there is connected a circuit which includes a flame relay 34 and which is formed by two current paths of mutually opposite polarity, the two current paths having a common capacitor 35. The first current path, which corresponds to the direction of current flow of the *d.c.* voltage source, comprises the series circuit of a first diode 36, a first winding 37 of the flame relay 34, a second diode 38 and the capacitor 35. The second current path again includes the capacitor 35 and also a third diode 39, a second winding 40 of the flame relay 34, and a fourth diode 41, which are all connected together in series.

The flame relay 34 has switching contacts (not shown) with which it indicates the presence of a flame, when the relay is in the energised condition. Its windings 37 and 40, which are each associated with a respective one of the above two current paths, are so designed that only one of the two current paths can cause the flame relay 34 to be actuated, while the other current only provides a holding current for the flame relay 34.

In the present embodiment, only discharge current from the capacitor 35, which flows in the second current path 35, 39, 40 and 41, can cause the flame relay 34 to be attracted, while charging current in respect of the capacitor 35, which flows in the first current path 36, 37, 38 and 35 through the first winding 37, can only hold the flame relay 34 in an energised condition for a limited period of time.

The flame relay circuit 4 also includes a switching means comprising a trigger stage formed by three transistors 42, 43 and 44, the input 19 of which is formed by the side of the capacitor 15 which is connected by the resistors 16 and 17 to *d.c.* voltage source 29, 30 and 31. The output transistor 44 of the trigger stage has its collector-emitter path connected between the supply line 33 and the bus line 11, and in the conducting condition short-circuits the circuit including the flame relay 34. The polarity of the output transistor 44 is such that it takes away the supply voltage across the first current path 36, 37, 38 and 35 and applies it to the charging resistor 32, and at the same time closes the second current path 35, 39, 40 and 41 for discharging the capacitor 35.

The transistor 43 has its collector-emitter path connected in parallel with the collector-base path of the output transistor 44. The base of the transistor 43 is connected by way of a voltage divider, comprising two resistor 45 and 46, to the junction between the resistors 16 and 17 and thus to the *d.c.* voltage source 29, 30 and 31. In the conducting condition, the transistor 42 connects the junction between the resistors 45 and 46 of the voltage divider to the line 11 by way of its collector-emitter path. The base of the transistor 42 forms the input 19.

In the above-described arrangement, the polarity of the voltage across the second ca-

pacitor 15 determines the instantaneous switching condition of the three transistors 42, 43 and 44.

When using the ionisation sensor 2, the above-described monitoring circuit or apparatus operates in the following manner.

When the transformer 9 is connected to the mains voltage, the capacitors 15 and 35 are charged. The capacitor 15 at the input 19 of the trigger stage 42, 43 and 44 is charged up within about 25 ms and in that condition causes the output transistor 44 to be in a non-conducting condition. The capacitor 35 in the circuit of the flame relay 34 can therefore be charged up by way of the diodes 36 and 38 and the first winding 37 of the flame relay 34. The current which then flows through the winding 37 is insufficient to energise the flame relay 34.

As soon as a flame is present at the ionisation sensor 2, the first capacitor 7 is charged up, within about 0.5 seconds, to the upper threshold voltage of the threshold switch 74, that is to say, until the break-down voltage across the Zener diode 22 is reached. The first transistor 20 of the threshold switch 74 is then switched into a conducting condition and the second transistor 21 is similarly switched abruptly by feedback circuitry. The transistors 20 and 21 activate a first and a second discharge circuit for the first capacitor 7.

The first discharge circuit serves to change the charge of the second capacitor 15, a discharge current from the first capacitor 7 flowing by way of the second capacitor 15, the resistor 28, the Zener diode 27, the resistor 23 and the transistor 20, back to the capacitor 7. The conduction voltage of the diode 18 restricts the charging voltage of the second capacitor 15. As soon as the capacitor 7 is discharged to such an extent that the voltage across the zener diode 27, which serves as a voltage-dependent switch, falls below the breakdown voltage thereof, reversal of the charge of the capacitor 15 to its original condition re-commences.

The second discharge circuit of the first capacitor 7, which circuit is activated for a longer period of time, is by way of the resistor 24, which primarily determines the residual discharge time, the resistor 23 and the transistor 20. As soon as the voltage drop across the resistor 23 falls below the emitter-base voltage which holds the transistor 21 in a conducting condition, both the transistors 21 and 22 switch over as a result of the feedback and make the discharge circuit of high resistance again. The size of the resistor 24 is not critical in this arrangement. It has only to be sufficiently low to be able satisfactorily to discharge the first capacitor 7, until the transistors 20 and 21 switch back.

As soon as the transistors 20 and 21 are again in a non-conducting condition, and on the assumption that the flame is still present, the capacitor 7 is re-charged and the cycle begins afresh.

The above-described change in the charge on the second capacitor 15 causes the input transistor 42 of the flame relay circuit 4 to be non-conducting. This causes the transistor 43 and the output transistor 44 to be put into a conducting condition, and the capacitor 35 is discharged by way of the diodes 39 and 41 and the second winding 40. The flame relay 34 is actuated and is now held in an energised condition by the discharge current during the following period of about 50 ms. When the change in the charge of the second capacitor 15 is concluded, the polarity of the voltage source 29, 30, 31 is restored again at the input 19 within about 50 ms, which can be adjusted with the resistor 16. The input transistor 42-conducts again the output transistor 44 is thus non-conducting. The first current path for charging the capacitor 35 is re-activated and holds the flame relay 34 in an energised condition.

As described hereinbefore, the condition of charge of the capacitor 7, which is influenced by the flame sensor 2, produces charge reversal of the capacitor 15, which occurs at a given rhythm which is influenced by the flame sensor. The continuously changing condition of charge of the capacitor 15 in turn causes switching of the output transistor 44 of the flame relay circuit 4 at the same rhythm, whereby the flame relay 34 can be held in an energised condition. In order to ensure this, the time between two discharges of the capacitor 35 may be about 900 ms maximum, otherwise the current falls below the holding current for the flame relay 34. Likewise the discharge time of the capacitor 35 should not be substantially less than 50 ms as otherwise the capacitor 35 is insufficiently discharged for the subsequent re-charging operation.

In order to ensure the necessary rhythm, it is advantageous for the time during which current flows in the first discharge circuit of the capacitor 7 to be short in comparison with the time during which current flows in the second discharge circuit, and for the ratio of the operative durations thereof to be at least 1:10. In the present embodiment, the change in the charge on the capacitor 15, produced by the first discharge circuit, occurs within about 2 ms, while discharge of the capacitor 7 is stopped after about 30 ms by the voltage falling below the lower threshold voltage of the threshold switch 74.

As each component of the circuit is involved in the realisation of the above-described charging and discharging cycles, any failure is indicated by a disorder in that cycle and thus by release of the flame relay 34. This gives the required fail-safe character.

The foregoing part of this description referred to operation of the monitoring circuit

when the flame sensor used is the ionisation sensor 2. The following part of the description relates to use of the UV-sensor 3. The UV-sensor 3 comprises a UV-cell 47 having a diode 48 and a protective resistor 49 connected in series therewith. As the series circuit of the UV-sensor 3 with the sensor circuit 1, which is of comparative high resistance, does not ensure clear glow discharge of the UV-cell 47, the capacitor 7 and the threshold switch 74 connected in parallel with the capacitor 7 are bridged by a shunt resistor 50.

The Zener diode 13 in the supply line to the UV-sensor 3 on the one hand prevents discharge of the capacitor 7 by way of the resistors 13, 14 and 50 during the current pauses and, on the other hand, makes it impossible for flame simulation to occur due to *a.c.* voltages occurring by a stray effect in a possibly very long sensor line. Such voltages far exceed the Zener voltage and are therefore conducted away.

When a flame is present at the UV-cell 47, the charging current of the sensor circuit, which current is controlled by the UV-cell 47, is possibly even greater than the holding current of the threshold switch 74, in spite of the provision of the shunt resistor 50. In this case, care must be taken to ensure that, after the first capacitor 7 has been charged, no further current pulses reach the capacitor 7. This purpose is served by the control circuit 5 (Fig. 1) or 6 (Fig. 2) respectively, which is operative temporarily to suppress the charging current, controlled by the UV-cell 47, to the first capacitor 7, in the cycle rhythm of the transistors 42, 43 and 44 of the flame relay circuit 4.

In the embodiment shown in Fig. 1, a means 51 which interrupts radiation to the UV-cell 47, in conjunction with the control circuit 5 which is defined by a broken line, serves to temporarily suppress the charging current to the first capacitor 7. Disposed in the path of the radiation are a fixed screen or shield 52 and a movable flap 53 which, being displaceable by means of a solenoid 54, can mask an opening in the screen 52. The abovementioned parts of the means 51 are all disposed in a housing forming the UV-sensor 3. One supply line of the solenoid 54 is connected to the positive hole of the *d.c.* source 29, 30 and 31. Disposed in a second line to the solenoid 54, which is connected to the negative terminal, that is to say to the bus line 11, is the collector-emitter path of an output transistor 55 of a trigger circuit comprising output and input transistors 55 and 56, respectively. In the trigger circuit, the base-emitter path of the output transistor 55 is connected in parallel with the collector-emitter path of the input transistor 56, with both emitters being connected to the line 11. The base of the output transistor 55 is connected to the positive pole of the current source 29, 30 and 31, together with the collector of the input transistor 56, by way of a common resistor 57. The base of the input transistor 56 is connected to the line 11 by a series circuit comprising a resistor 58, a Zener diode 59 and a capacitor 60. By means of a tap between the capacitor 60 and the Zener diode 59, the capacitor 60 is connected to a charging resistor 61 and a diode 62 shunting the charging resistor 61, between the supply line 33 and the bus line 11, and is therefore connected in parallel with the circuit 35 to 41 which includes the flame relay 34. The series circuit comprising the capacitor 60 and the charging resistor 61 or the diode 62 can therefore be short-circuited, together with the circuit 35 to 41 including the flame relay 34, by the output transistor 44.

The switching condition of the trigger circuit 55 and 56 and thus also the position of the flap 53 in the UV-sensor 3 is dependent on the voltage across the capacitor 60. In the rest condition, that is to say in the absence of UV-radiation for the time being, the capacitor 60 is charged in about 300 ms to the sum of the Zener voltage of the Zener diode 59 and the voltage drop across the base-emitter path of the transistor 56, whereby the input transistor 56 is put into a conducting condition and the output transistor 55 into a non-conducting condition. The opening in the screen 52 is then open. A diode 63 which is connected in parallel with the solenoid 54 protects the transistor 55 from excessive voltages.

As soon as current pulses occur in the UV-cell 47, the capacitor 7 begins to charge, for which purpose the pulses of three alternations or cycles of the *a.c.* supply voltage are sufficient. The pulses do not have to occur in an interrelated mode; in the case of a weak radiation source the pulses may occur individually within a period of 600 ms and in spite of that may still be evaluated as signals signalling a flame, as described hereinafter. It will be seen from this that, of the 30 alternations or cycles which occur during a period of 600 ms, when the frequency used is 50 Hz, the presence of only 10% is sufficient for flame detection. This is a decisive advantage of the above-described flame monitoring means, in that the UV-sensor sensitivity thereof is very high.

As soon as the voltage across the capacitor 7 in the sensor circuit 1 reaches the trigger voltage of its threshold switch 74, the operation of changing the charge on the capacitor 15, as already described above, is initiated. This causes the trigger stage 42, 43, 44 in the flame relay circuit 4 to respond, and the output transistor 44 thereof is put into a conducting condition, which has two effects. Firstly, the resulting discharge circuit for the capacitor 35 in one current path, by way of the winding 40, causes energisation of the

flame relay 34. Secondly, the capacitor 60 in the control circuit 5 is discharged. The trigger circuit 55, 56 thereof responds, the solenoid 54 is energised and the flap 53 interrupts the UV-radiation. There is no further supply of charge to the capacitor 7 and discharging thereof is terminated after a period of about 30 ms, by the threshold switch 74 switching back. In this arrangement, the circuit is of such a design that even good UV-cells 47 can still produce one or two current pulses directly after the UV-radiation stops, without the change in the charge on the capacitor 15 and thus the entire cycle being disturbed. In comparison, the charging and discharging cycle in the flame relay circuit 4 is disturbed if, during the period of about 300 ms during which the cell is masked by the flap 53, the UV-cell 47 nonetheless produces current pulses which occur on a irregular basis, this being a phenomenon which occurs with ageing UV-cells. The flame relay 34 is then released, even if the flame is burning correctly.

In trouble-free operation, the flame relay 34 remains actuated within a repetition time in respect of discharge of the capacitor 35 of between about 350 and 950 ms. As soon as the repetition time goes outside of the range defined by those time limits, the relay 34 is released. By virtue of the above-described control circuit 5, a further advantage of the apparatus is that, in spite of the high level of sensor sensitivity, any defect both in the circuit 5 and in the UV-cell 47 itself is detected at any time, that is to say, also during operation, very quickly, that is to say, within less than one second after it occurs. Therefore, the above-described apparatus is particularly suitable for an installation which is continuous operation.

In comparison, the flame monitoring means shown in Fig. 2 is fail-safe in regard to UV-monitoring only in installations with intermittent operation, because there is no repetitive masking of the UV-cell 47. However, the UV-sensor 3 may be of a simpler design configuration. The circuit is precisely the same as that shown in Fig. 1, except for the foregoing comment relating to the UV-sensor 3, and with the exception of the circuit 6 which is indicated by a broken line in the drawing. The circuit 6 similarly to the circuit 5 in Fig. 1, serves for temporarily suppressing the further charging current to the capacitor 7, although this occurs purely electrically. There are therefore no movable components.

The circuit 6 comprises a transistor 64 whose emitter-collector path is connected in parallel with the first capacitor 7, whose collector is tapped off at the junction between the Zener diode 13 and the resistor 14, and whose emitter is connected to the bus line 11. The base-emitter path of the transistor 64 has a capacitor 65 connected in parallel therewith. For this purpose, the capacitor 65 is connected at one side of the line 11 and at the other side to the base of the transistor 64 by way of a Zener diode 66 and a resistor 67. Also connected in parallel with the base-emitter path of the transistor 64 is a diode 73 which is arranged to be of opposite polarity to the base-emitter path. Furthermore, the capacitor 65, in series with a resistor 68 with which a diode 69 is connected in parallel, and a further resistor 70, is connected in parallel with the circuit which includes the flame relay 34. Therefore, the capacitor 65 can also be short-circuited, together with the circuit of the flame relay 34, by the output transistor 44 of the flame relay circuit 4. A further series circuit comprising a resistor 71 and a diode 72 connects the base of the transistor 64 to the terminal of the winding 29 which supplies the bus line 33. In this arrangement, the polarity of the diode 72 is such that the alternations acting at the base of the transistor 64 are of the same phase as the alternations flowing through the UV-cell 47.

The above-described circuit 6 operates in the following manner: In the condition of operational readiness, that is to say when a flame is not yet present, the capacitor 65 is charged by way of the resistors 68 and 70 from the voltage source 29, 30 and 31. The charging voltage is restricted by the voltage drop across the Zener diode 66, the resistor 67 and the diode 73. During negative alternations at the diode 72, only apart of the current applied to the diode 73 flows away through the resistor 71 and the diode 72 so that the transistor 64 is always in a non-conducting condition. After a flame is produced, therefore, the transistor 64 which is connected in parallel with the sensor circuit 1 does not initially impair charging of the capacitor 7. The same procedure as was described with reference to Fig. 1 occurs. The capacitor 15 undergoes a change in charge, and the output transistor 44 on the one hand closes the discharge circuit for the capacitor 35 and the flame relay 34 is energised. On the other hand, the transistor 44 discharges the capacitor 65 by way of the diode 66 and the resistor 70. This means that, now, each alternation in respect of which the diode 72 is conducting can produce a base current in the transistor 64, so that the transistor 64 periodically conducts. These base current alternations are in phase with the current pulses of the UV-cell 47. Therefore, the UV-cell current no longer flows to the capacitor 7 but is directly conducted away, by way of the collector-emitter path of the transistor 64. The capacitor 7 can thus be discharged, its threshold switch 74 switches back and the entire operation begins again.

The above-described flame monitoring means includes the advantage of comprising only a single fail-safe amplifier circuit with only one relay, which can be used for both

ionisation sensors and also for UV-sensors, and in which high levels of sensor sensitivity can still be achieved, even with an UV-sensor which is made fail-safe by periodic masking. The above-described, continuously occurring change in condition of the structural groups gives the fail-safe nature involving all components. Any failure of a component causes release of the flame relay.

By virtue of the cycle ratio of the charging and discharging cycles of the various circuits being intentionally selected at a high value, and because the cycle frequencies are throughout greatly different from the 50 Hz mains frequency, the danger of a flame being simulated as a result of the occurrence, which is generally unavoidable in practice, of an *a.c.* voltage at the amplifier input due to a stray effect, is entirely eliminated.

The advantageous use of the above-described circuits with UV-sensors is not restricted solely to this type of sensor. They could also be operated, with suitable adaptation, with a photoelectric resistor.

CLAIMS

1. A flame monitoring means comprising

a series circuit of a first capacitor and a flame sensing means, said series circuit being connected to receive an *a.c.* voltage in use of the flame monitoring means,

a flame relay,

a threshold switch arranged to be controlled by the voltage across the first capacitor and operative to produce a signal for energising the flame relay when the threshold switch reaches a switching threshold thereof,

a switching means for periodically blocking the signal to the flame replay and simultaneously discharging the first capacitor,

a circuit which which includes the flame relay and can hold the flame relay in a position thereof indicating a flame, only by an alternating signal,

a second capacitor connected by at least one charging resistor to a direct current source, the switching condition of the switching means being determined by the voltage at the second capacitor, and

first and second discharge circuits activatable by the threshold switch for discharging the first capacitor, the first discharge circuit serving to change the charge on the second capacitor and comprising a parallel circuit of the second capacitor and comprising a parallel circuit of the second capacitor with a diode which limits the magnitude of the changed-polarity voltage across the second capacitor, a resistor, and a voltage-dependent switch which interrupts the charge-changing process, and the second discharge circuit including a resistor which determines the residual discharge time of the first capacitor.

2. A flame monitoring means according to claim 1, wherein the duration of current flow in the first discharge circuit is short in comparison with the duration of current flow in the second discharge circuit, the ratio of said durations being at least 1:10.

3. A flame monitoring means according tc claim 1, wherein said switching means comprises a trigger stage having an input formed by a terminal of the second capacitor which is connected to the *d.c.* voltage source, wherein said trigger stage has an output switch which, in the conducting condition, short-circuits said circuit which includes the flame relay, and wherein, the condition of charge of the second capacitor which is produced by the direct current source, said output switch is open.

4. A flame monitoring means according to claim 3, wherein said circuit which includes the flame relay is formed by two current paths which are of mutually opposite polarity and which have a common capacitor, the first said current path corresponds to the direction of current flow of the *d.c.* voltage source and comprises a series circuit comprising a first winding of the flame relay, at least one diode and said common capacitor, and the second said current path comprises a series circuit comprising said common capacitor, at least one further diode and a second winding of the flame relay, the arrangement being such that only one of the two current paths can cause energisation of the flame relay, while the other current path only supplies a holding current for the flame relay.

5. A flame monitoring means according to claim 4, wherein only the discharge current of said common capacitor which flows in said second current path when said output switch of said trigger stage is in a closed condition, causes energisation of the flame relay, while the charging current of said common capacitor, which flows in said first current path through the first winding, can hold the flame relay in an energised condition only for a limited period of time.

6. A flame monitoring means according to any one of claims 1 to 5, wherein the flame sensing means comprises an ionisation sensor.

7. A flame monitoring means according to any one of claims 3 to 5, wherein the flame sensing means comprises a UV-cell, a shunt resistor shunts the first capacitor and the threshold switch, which is connected in parallel with the capacitor, and a control circuit operative in the cycle rhythm of the trigger stage is provided for temporarily suppressing the charging current, controlled by the UV-cell, to the first capacitor.

8. A flame monitoring means according to claim 7, wherein said control circuit includes means for interrupting the radiation to the UV-cell, said interrupting means is controlled by means of a trigger circuit in dependence on the voltage across a capacitor, such capacitor is in series with at least one charging resistor,

and a diode shunting the charging resistor is connected in parallel with said circuit which includes the flame relay and can thus be short-circuited by said output switch of said trigger stage, together with the circuit which includes the flame relay.

9. A flame monitoring means according to claim 7, wherein said control circuit comprises a transistor having an emitter-collector path connected in parallel with the first capacitor and a capacitor which is connected in parallel with the base-emitter path of said transistor, in series with a Zener diode, wherein the last-mentioned capacitor, in series with at least one resistor and a diode for shunting the resistor, is connected in parallel with the flame relay circuit and can be short-circuited by said output switch of said trigger stage, and wherein a diode which is connected in an opposite polarity mode with respect to the base-emitter path of the transistor is connected to said base-emitter path and, in series with a further diode, an *a.c.* voltage acts in use at the base of the transistor in such a way that the alternations thereof are in phase with alternations flowing through the UV-cell.

10. A flame monitoring means according to claim 7, claim 8 or claim 9, wherein a Zener diode is arranged in the series circuit of the first capacitor and the UV-cell.

11. A flame monitoring means substantially as herein described with reference to Fig. 1 or Fig. 2 of the accompanying drawings.

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ABSTRACT:

CHG DATE=19990617 STATUS=O> A flame monitoring means is arranged for selective use with an ionisation sensor (2) or a UV-sensor (3) which are connected in series with a first capacitor (7) to an a.c. voltage (U1). The sensor current charges up the capacitor (7). A threshold switch (74) provides for voltage-dependent discharging of the capacitor (7) and transmits the charge thereof partly to a second capacitor (15), and changes the charge thereof. The voltage thereof influences the input (19) of a trigger stage (42, 43, 44). An output switch (44) of the trigger stage short-circuits the supply circuit of a flame relay (34) in a temporally restricted permissible

switching cycle. In the short-circuited condition, a capacitor (35) is discharged by way of the flame relay (34) which is then energised, and the subsequent charging current holds the flame relay (34) in an energised condition The output switch (44) also short-circuits a further capacitor (60) and, by way of a trigger circuit (56, 55), controls a flap (53) for masking the UV-radiation for a restricted period of time. Only the restricted UV-radiation permits the production of the permissible switching cycle, so that the flame relay (34) remains energised.